II. REMARKS

Claims 1-24 are in the application. Claims 1 and 20 are in independent form.

Objections to the drawings

The Examiner has objected to FIG. 2A and FIG. 2B as "failing to comply with 37 C.F.R. 1.84(p)(5) because they include the reference sign '210' which is not mentioned in the description." Applicants submit that reference sign 210 is found in the description in the last sentence of paragraph [1028] which states, "FIG. 2A shows an outlet 210 from each gun chamber 110 to an associated ion pump."

The Examiner has also objected to FIG. 6. According to the Examiner, "the reference signs 414, 424, 430, 432, and 440 . . . must be shown or the feature(s) cancelled from the claim(s)." Applicants have submitted proposed amendments to paragraph [1040] and FIG. 6. Because the proposed amendments merely describe what is already shown in FIG. 6, the amended language does not contain new matter.

Accordingly, Applicants respectfully request that the objections to the drawings be withdrawn.

Objections to the Specification

The required correction to the section of the specification entitled "Abstract" is hereby submitted by Applicants. The required correction to paragraph [1038] is also hereby submitted. These amendments are submitted to correct typographical errors, and no new matter is added.

The Examiner has objected to the disclosure on the grounds that it does not describe the reference sign "210" appearing in FIG. 2A and 2B. Applicants submit that reference sign 210 is found in the description in the last sentence of paragraph [1028] which states, "FIG. 2A shows an outlet 210 from each gun chamber 110 to an associated ion pump."

Accordingly, Applicants request that these objections to the specification be withdrawn.

Objection to the Claims

An amended claim 13 has been submitted with the requested spelling of "Wien filter."

Rejections under 35 U.S.C. § 112

Claims 7 and 8

Claim 7 stands rejected under 35 U.S.C. § 112, second paragraph, "as being incomplete for omitting essential structural cooperative relationships of elements."

Claim 7 claims "[t]he apparatus of claim 1, in which each of the ion optical columns includes optical elements and in which corresponding ones of at least one of the optical elements in different ones of the ion optical columns within a single gun chamber comprise *an optical element bar* to provide a common voltage to corresponding optical elements within the gun chamber. (emphasis added).

Applicants respectfully submit that the Examiner appears to be confusing bar 172 discussed in paragraph [1027] with optical element bar 310 discussed in paragraphs [1031] to [1032]. Bar 172 is simply a part of the valve system that can be used to vacuum isolate the gun chamber in the embodiment shown in FIG. 1 of the instant Application. As seen in the embodiment shown in FIG. 3, optical elements for multiple ion columns can be formed directly by the holes in conductive bars 310. Bars 310 are plural in the specification because more than one such bar is present in the embodiment shown and discussed. However, multiple bars 310 need not be present. As a result, claim 7 is directed at an apparatus in which at least one corresponding optical element in different ion columns within a single gun chamber comprises an optical element bar.

Claim 8 also stands rejected under 35 U.S.C. § 112, second paragraph, "as being incomplete for omitting essential structural cooperative relationships of elements." The Examiner states that the language of claim 8 which recites that "optical elements are placed in the optical element bar to allow independent control of optical elements" is contradictory to claim 7 and "would be principally impossible . . . since the [optical element bar] has a common voltage for all."

Applicants submit that the Examiner is ignoring relevant language in claim 8. Claim 8 claims "[t]he apparatus of claim 7, in which *electrically isolated lens elements* are placed in the optical element bar to allow independent control of some of the optical elements comprising the optical element bar." (emphasis added). This claim is supported by paragraph [1035] of the specification which provides that "[a]nother method of providing high voltage insulation to lenses 128 entails using a conductive bar 310, with an insulating insert placed in a hole in the bar, and then a conductive lens placed in the insulating insert." Because the lens elements recited in claim 8 are electrically isolated, they can be controlled independently from other optical elements in the optical element bar.

Applicants submit that neither claim 7 nor claim 8 omit any essential matter. As a result, Applicants request that the Examiner's rejection under 35 U.S.C. § 112 be withdrawn.

Claims 10 and 11

The Examiner also objects to claims 10 and 11. Although not expressly stated, Applicants assume that these objections are also based upon 35 U.S.C. § 112. Applicants have submitted amendments to claims 10 and 11.

Rejections under 35 U.S.C. § 103

Claim 1

Claim 1 stands rejected as being unpatentable over Jones et al. (U.S. Pat. No. 4,902,898) in view of Stengl (U.S. Pat. No. 4,985,634.) To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

Applicants' claim 1 claims "[a]n apparatus *including multiple ion guns and multiple associated ion optical columns* for focused ion beam processing of materials or imaging, comprising: one or more sealable ion gun chambers; one or more ion guns positioned within each of the one or more ion gun chambers, each ion gun capable of generating an ion beam; multiple ion optical columns, *each ion optical column being associated with one of the multiple ion guns* for focusing and directing the corresponding ion beam toward a target; a primary

vacuum chamber for containing a target for processing or imaging; a vacuum valve associated with each of the ion guns, the vacuum valves selectively opening to allow the corresponding ion beam to pass from the associated ion gun to the target or selectively closing to seal the corresponding ion gun chamber." (emphasis added).

Here, a *prima facie* case of obviousness has not been established for claim 1 since the prior art references when combined do not teach or suggest all the claim limitations found in claim 1. Neither reference teaches an apparatus including multiple ion guns and multiple associated ion optical columns.

Jones teaches the use of one single ion source to supply a "ribbon" of charged particles. This ribbon of particles is shaped by an "array wand" which uses a blocking layer to block some of the incoming charged particles while allowing other particles to pass through apertures and continue toward the target. In this way, the ions from one source can be formed into a number of collimated beams.

Nowhere does Jones suggest that multiple ion sources could be used. For example, in Col. 2, lines 63-65, Jones recites that "[w]and optics column 20 includes a source of charged particles 22 in the form of an electron or ion source which supplies a ribbon of charged particles." Note that both the optics column and the ion source are expressly singular.

This distinction between using a single ion source and using multiple ion sources is significant because using multiple ion guns increases the number of ions impacting the target and therefore increases the processing rate. The hydrogen ion source described in Jones might be sufficient to produce multiple ion beams suitable for exposing photoresist, but such a design would not be suitable for nanofabrication. For example, if an ion beam produced by a single Liquid Metal Ion Source were to be split into multiple ion beams, each of the multiple beams would have a proportionately smaller beam current. And, as a result, processing speed—the rate at which material is removed or deposited—would be slower for each of the multiple beams. In contrast, the use of separate ion sources and separate ion optical columns allows multiple ion beams that are each capable of substantially the same resolution and beam current as that of a beam produced in a single gun FIB system. As a result, in the invention disclosed

and claimed by Applicants, accuracy and precision are not degraded as processing speed is increased.

The Stengl reference also fails to teach an apparatus including multiple ion guns and multiple associated ion optical columns. Instead, Stengl teaches an ion projection lithography apparatus with a single ion source. Nowhere does Stengl teach an apparatus with multiple ion guns or multiple ion optical columns.

Since the prior art references when combined do not teach or suggest all the claim limitations found in claim 1. Applicants respectfully request that the 103 objections to claim 1 be withdrawn.

Claims 2 and 3

Claims 2 and 3 stand rejected over Jones in view of Stengl and Ngo et al. (Proceedings 43rd International Conference on EIPBTN). As discussed above, to establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Here, the cited references do not contain all of the claim limitations in claims 2 and 3.

The Examiner acknowledges that Jones as modified by Stengl does not teach that a single ion gun chamber may contain one or more ion guns. The Examiner then states that Ngo discloses "a sealable ion gun chamber shown in FIG. 1 equipped with a multiple of extraction holes." As is the case for Jones, discussed in detail above, Applicants submit that the Examiner's reliance on Ngo is misplaced. Ngo simply does not teach multiple ion guns or multiple gun chambers. Instead, Ngo teaches the use of one multicusp plasma ion source to produce multiple ion beamlets.

The Examiner further states that the recitation of multiple sealable ion gun chambers each including one or more ion guns is a mere duplication of parts. Applicants respectfully disagree. The use of multiple gun chambers as described by this application is functionally different from the use of one gun chamber and provides significant advantages. Separate gun chambers allow some ion guns to be replaced while others remain in service. The use of multiple gun chambers

also allows a larger number of total ion guns since, as disclosed by the specification, the number of guns in one gun chamber is preferably limited to about five.

Accordingly, Applicants request that the Examiner's 103 objection to claims 2 and 3 be withdrawn.

Claim 8

Claim 8 also stands rejected over Jones in view of Stengl and Ngo. Once again, the cited references do not contain all of the claim limitations in claim 8. Claim 8 claims "[t]he apparatus of claim 7, in which *electrically isolated lens elements are placed in the optical element bar* to allow independent control of some of the optical elements comprising the optical element bar." (emphasis added). Stengl teaches an ion projection lithography apparatus with a single ion source and a single ion beam and so has no application to a structure serving as an optical element for multiple ion columns. While Jones and Ngo do teach the use of a common conductive layer or layers that can serve as an optical element for multiple ion beams, neither Jones nor Ngo teaches electrically isolated lens elements placed in such an optical element layer. NGO

Accordingly, Applicants request that the Examiner's 103 objection to claim 8 be withdrawn.

Claims 9-11 and 13-14

Claims 9-11 and 13-14 stand rejected over Jones in view of Stengl and further in view of Lo et al. (U.S. Pat. No. 6,232,787). To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Additionally, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine and modify reference teachings.

The Examiner acknowledges that Jones and Stengl do not teach a means for collecting

secondary particles through a lens element for imaging or characterizing the target surface. However, the Examiner further states that Lo discloses a charged particle beam system with a means for collecting secondary particles through a lens element and that it would have been obvious at the time the invention was made "to use a means for collecting secondary particles as suggested by Lo."

Applicants disagree. Lo discloses a defect detection device that uses a scanning electron microscope. The lens found in Lo's FIG. 1 and cited by the Examiner is a magnetic-immersion type lens. (Col. 3, line 65) As such, it would not be suitable for use as an optical element for focusing and directing an ion beam toward a target, as is required by claim 9 (through the language of independent claim 1). An electron beam, such as the beam disclosed by Lo, can be focused by this type of magnetic lens, but a typical ion beam cannot. This is because ions, such as those extracted from a liquid metal ion source, are typically too massive to be focused by reasonably sized magnetic lenses. As a result, electrostatic lenses are used in ion beam optical columns. Because the lens described in Lo could not be expected to focus an ion beam, a person of ordinary skill would have had no motivation to combine Lo with the other references.

This distinction is even more apparent in new dependent claim 27. Accordingly, Applicants request that the Examiner's 103 objection to claims 9-11 and 13-14 be withdrawn.

Claim 12

Claim 12 stands rejected under 35 USC § 103(c) over Jones in view of Stengl and Lo and further in view of Krans et al. (U.S. Pat. No. 6218664). 35 USC § 103(c) states that "Subject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f), and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person."

At the time the invention of the present application was made, the subject matter of U.S. Pat. No 6,218,664 and the claimed invention were both owned by or subject to an obligation of

assignment to FEI Company. Accordingly, Applicants request that the Examiner's 103 objection to claim 12 be withdrawn.

Claims 15 and 16

Claims 15 and 16 stand rejected over Jones in view of Stengl and further in view of Mack (U.S. Pat. No. 6,222,196). The Examiner states "[t]he limitation regarding beam tilt is inherent in Jones, addressed by parameter θ as part of the x,y,θ scan . . ." Applicants respectfully disagree. Jones contains no mention of changing the angle of incidence between the beam and sample surface. Although Jones is certainly not clear on this point, Applicants believe it more likely that the θ parameter refers to the orientation of the ion beam ribbon on the sample surface since this is clearly a variable setting and the reference makes absolutely no mention of a tilting stage or tiltable ion beam column.

Examiner further states "a beam tilt of about three degrees is expressly recited by Mack in Col.6/ll.12-42 in reference to Fig. 4A & 4B. It would have been obvious . . . to tilt the beam(s) by about three degrees, since this amount of tilt is known to be appropriate with regard to the purpose thereby envisioned."

Again, Applicants respectfully disagree. Mack teaches an apparatus for ion beam implantation. The entire purpose of ion implantation is to direct a beam of dopant ions toward a wafer surface so that the ions become imbedded in the wafer. Obviously, during ion implantation it is desirable to keep sputtering on the wafer surface to a minimum. Sputtering away surface material, however, is one of the principal uses of Applicants' invention.

As a result, a person of ordinary skill in the art would have had no reason to combine the references in the manner suggested by the Examiner. Accordingly, Applicants request that the Examiner's 103 objection to claims 15 and 16 be withdrawn.

Claims 20-23

Claims 20-23 also stand rejected over Jones in view of Stengl and Ngo. As is the case for independent claim 1 discussed above, claim 20 has a claim limitation requiring multiple ion

sources. As also discussed above, neither Jones nor Stengl teaches this claim limitation. The same is true for Ngo. Instead, Ngo teaches the use of one multicusp plasma ion source to produce multiple ion beamlets.

Also, none of the cited references teach optical elements formed from a flat conductive bar having electrically isolated lenses as claimed by claim 22. And further, none of the cited references teaches optical elements formed from a flat non-conductive bar having electrically isolated lenses as claimed by claim 23.

Accordingly, Applicants request that the Examiner's 103 objections to claims 20 23 be withdrawn.

All Remaining Claims

Applicants submit that the remaining claims, being dependent from claims that are allowable for reasons states above, are also allowable. Accordingly, Applicants request that the objections to these remaining claims also be withdrawn

Double Patenting Objections

Claims 1-24 have also been provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-26 of co-pending U.S. Pat. App. 09/780,876. Applicants initially note that such a provisional double patenting objection is only proper where the conflicting claims are not patentably distinct from each other. Applicants respectfully disagree that a provisional double patenting objection is appropriate for claims 1-24.

Claims 1-24 of the current application are all directed at an apparatus which includes multiple ion guns and multiple ion optical columns. Claims 1-26 of the co-pending application are all directed at a focused ion beam apparatus using through-the-lens detection of secondary particles. A multi-column focused ion beam system is not an obvious variation of a single column focused ion beam system using through-the-lens detection. Although some of the dependent claims in the two applications may have similar elements, when the dependent claims

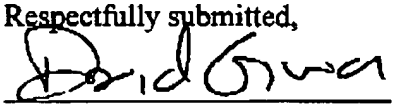
are considered as a whole (including the limitations of each parent independent claim), claims 1-24 of this application are all patentably distinct from claims 1-26 of the co-pending application.

Applicants therefore request that the provisional double-patenting rejection for claims 1-24 be withdrawn. In any event, Applicants expect that the provisional double-patenting rejection will be withdrawn if the claims at issue in this application are allowed before the claims in the co-pending application.

III. CONCLUSION

Applicants submit that the application is now in condition for allowance and respectfully request allowance of the case.

Respectfully submitted,



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